International Journal of Engineering and Applied Sciences (IJEAS)
ISSN: 2394-3661, Volume-2, Issue-9, September 2015

Case study possibilities of reducing energy of residential building

Ing. Anton Pitoňák, Ing. Martin Lopušniak

***Abstract*— Residential buildings nowadays have a high energy consumption. This is due to the fact, that many of them are still not retrofitted. As the European Union in the new directive (known as the 20-20-20) adopted three major commitments to meet the criteria by 2020, it is necessary to pay attention to the retrofit. The aim of the work is to point out how contribute to reducing energy consumption and why pay more attention to the comprehensive retrofit over the partial retrofit.**

***Index Terms*—Reducing energy, Energy, Panel construction, Retrofit.**

I. Introduction

The European Union in the new directive (known as the 20 – 20 – 20) adopted three major commitments to fulfill the criteria by 2020. The first of these is a reduction in total greenhouse gas emissions by at least 20% compared to 1990. The second is the reduction of energy consumption in countries the EU also by 20% and the third commitment is to achieve a 20% share of renewable energy in total energy consumption [1].

In residential buildings is great potential. It is wise to leave these residential buildings to decay and build a new modern residential houses on the green meadows? The fact is, that the existing residential buildings do not meet the conditions at present as: architectural, sanitary, functional requirements, energy and others. The restoration should be approached comprehensively, as in Slovakia restores mostly part. It should be ensured people comfortable housing, introduce intelligent systems that will provide people living healthier and will reduce the need for energy. The aim of this work is to determine and compare each model examples of residential buildings based on heat use for space heating.

II. History of building stock in panel construction

A. Building stock in panel construction abroad to 1990

The first panel houses appeared in the Netherlands after the First World War. In Germany, discovered in 1923, the first block of panel houses was built in 1939 in Paris, similar blocks were also built in Sweden and Finland. Construction of panel houses served as a quick and cheap housing. But anywhere in the West Europe it was not build on such a massive scale as in the Eastern bloc. Western Europe since their construction dropped in the 70 years, while in Eastern Europe they were built until the early 90s of the 20th century [2].

Ing. Anton Pitoňák, Department of Building Physics, The Technical University of Košice/Faculty of Civil Engineering, Košice, Slovakia, +421/949 466 431 .

Assoc. prof. Ing. Martin Lopušniak, PhD, Department of Building Physics, The Technical University of Košice/Faculty of Civil Engineering, Košice, Slovakia, +421/907 921 130 .

B. Building stock in panel construction in Slovakia to 1990

Bulk construction did not exist there, all buildings were built as originals, typing was at a low level. From building materials dominated pieces based on natural stone and ceramics. It began with the construction of the first residential colonies and the first neighborhoods of 500 flats in Bratislava on the principle of multiple projects. Originated residential brick-based technologies. Later were added technologies poured concrete, prefabricated technology of large-size panels and experimental solutions. It started with the use of metric bricks with thick perimeter bearing walls 375 mm. For other technologies accrued the first panel system type G (Gottwaldov, nowadays Zlín city), followed construction system BA (USSR) with a combination of skeletal and panel system and the system of floated concrete LB. From 1961 to 1970 it began a rapid development of construction of the panel residential buildings on the types of documents, approved by the Ministry of Construction in 1962 (T 06 B, T 08 B with regional variants, ZT) [3].

C. Residential houses in construction systems built in period 1949 – 1992

T 11 – T 17, T 20, T21, T 01 B – T 03 B, G 57 (Gottwaldov); SG 60, BA, LB (float concrete); MB (prefabricated concrete), MS 5; MS 11 (prefabricated system), PV – 2, PD – 62 (66), NMB, K 61 (variant of Kosice), T 05 B – T 09 B, ZT (joint type); ZTB (joint type Bratislava), BA - BC (Bauring - Camus), B 70, BA - NKS I/1; BA - NKS I/2, P 1.14; P 1.15; P 1.24/25, PS 82 (regional variants of PP, ZA, BB, TT), U 65 (variant of Banska Bystrica) [4], [5].

Years 1961 - 1990 can be included between the years with the highest concentration of flats construction (family houses, flats). In particular, the largest representation of the construction was achieved in 1971 – 1980s.

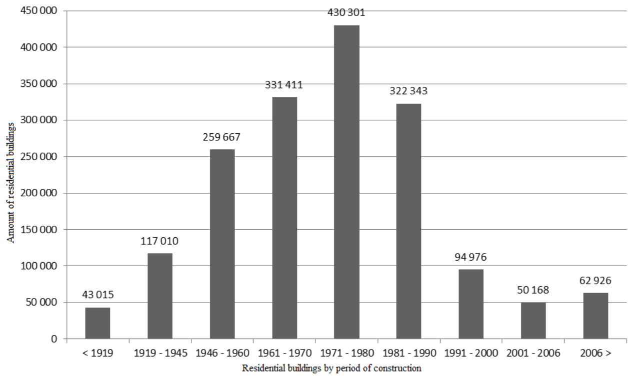

Fig. 1 Flats by period of construction; 2011 [6]

III. Calculation method

The calculation is solved according to EN ISO 13790 monthly quasi-steady method of project evaluation energy

demands. Calculation procedures in this International Standard is limited to the sensible heat i.m. not considering latent heat.

A. Standard requirements for the processing of calculation, STN 73 0540

Typ of construction	Transmission heat loss coefficient U (W/m².K)			
	Maximal value	Normalized value	Recommended value	Recommended target value
	U max (W/m².K)	U_N (W/m².K)	U_{r1} (W/m².K)	U_{r2} (W/m².K)
The external wall and sloping roofs of residential space heating with a slope > 45°	0,46	0,32	0,22	0,15
Flat and angled roof with a slope ≤ 45°	0,30	0,20	0,10	0,10
The ceiling above the external environment a)	0,30	0,20	0,10	0,10
The ceiling above unheated spaces a)	0,35	0,25	0,15	0,15
Ceiling heat flow from the top down to 15 K	1,60	0,95	0,60	0,35

Fig. 2 Transmission heat loss coefficient U [7]

The normalized values are in force at present. From 2016 will be valid recommended values. Recommended target values will be valid from the year of the 2020.

IV. MODELING APPROACHES RESIDENTIAL BUILDINGS

In this paper we assess and compare three model approaches residential buildings.

- Residential buildings without retrofit,
- Residential buildings after passing the partial retrofit,
- Residential buildings after passing comprehensive retrofit.

In one type of residential building, structural systems PS - 82 - PP let us show you these three approaches of retrofit. Residential buildings in Slovakia are insulated on parts, inconsistent with not too much impact on solving the energy problem. If there will be the comprehensive retrofit on a large scale, so that the whole complex will be restored, what impact to energy will it be? Will it be relevant? What do we achieve? Will it be the interesting solution for our country?

Fig. 3 Schematic 3D model of residential building PS – 82 – PP

Table 1 Input data about residential building

Total floor area A_f	1 624 m^2
Built-up volume of the building V_b	4 633 m^3
Cooling surface of external wall	1 098 m^2
Cooling surface of flat roof	203 m^2
Cooling surface of the ceiling	203 m^2
Cooling surface of windows constructions	258 m^2

A. Residential buildings without retrofit

Technical condition of panel houses without reconstruction is currently unsatisfactory. These residential buildings do not meet sanitary, thermal, energy and other requirements. In the next table there are structure forming the heat exchange of the panel system and thermal properties. Residential house is in original condition. In the calculation it is calculated with natural ventilation.

Table 2 Input data about residential building

Construction	U [W/(m^2.K)]
External wall	0,53
Flat roof	0,40
Ceiling above unheated floor	0,53
Windows constructions	2,70

B. Residential buildings after passing the partial retrofit

In Slovakia, residential buildings mostly partially renewed. This kind of retrofit is relating to only an residential building and building structures constituting the heat exchange casing. It is about the replacement of original window constructions for new one, mostly based on PVC, with better heat and technical characteristics and application of thermal insulation composite system (ETICS), whether based on EPS or mineral wool or other thermal insulation materials with new paintings. It is also necessary to regulate the heating system.

Table 3 Input data about residential building

Construction	U [W/(m^2.K)]
External wall	0,32
Flat roof	0,20
Ceiling above unheated floor	0,53
Windows constructions	1,40

Construction of residential building meet the standard requirements of STN 73 0540. In the calculation is considered the natural ventilation.

C. Residential buildings after passing the comprehensive retrofit

Comprehensive retrofit is not confined only to the residential building (thermal heat insulation packaging, insulation distribution, the lifts exchange, new technical equipment), but it deals with improving the entire settlement, urbanism design, parking areas... There is a great potential in the residential buildings and in the comprehensive reconstruction should the potential to maximize (enlarge usable area of housing units; link several apartments into one, either horizontally or vertically; modernizing architectural site of a residential building; application of solar and photovoltaic systems for residential house or integrating these systems directly into the facade; application of intelligent control systems).

Table 4 Input data about residential building

Construction	U [W/(m^2.K)]
External wall	0,15
Flat roof	0,10
Ceiling above unheated floor	0,35
Windows constructions	0,60

Construction of residential house meet the recommended target values of STN 73 0540. These values will be considered standard since 2020. In the calculation is considered a forced ventilation with heat recoveries. Considered the window constructions with triple glazing.

V. Results

The resulting values for calculating heat energy demand solution of modelling approaches of residential houses.

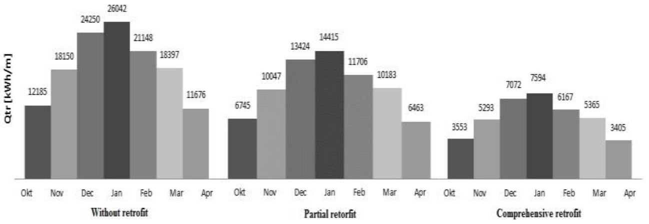

Fig. 4 Transmission heat loss coefficient

Heat loss transmission is closely related to the average heat transfer coefficient $U_{e,\ m}$. The difference between the $U_{e,\ m}$ in each variant is 45 % respectively. 71 %, the difference of heat loss transmission are amount to 45 % respectively. 71 %. The difference is caused by different thermal insulation of variants.

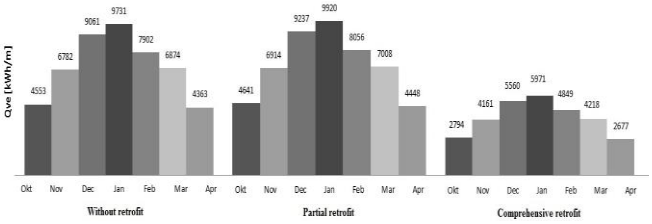

Fig. 5 Ventilation heat loss coefficient

In the first and second variant it is provided the air exchange of the building by natural ventilation. The calculation is counted for building space V_b of the building, there is such a calculation of differences in results (2 %). In a variant of comprehensive retrofit the air exchange is ensured by forced ventilation unit with heat recovery. In the calculation it is considered that only 20 % air exchange is secured by infiltration. Heat loss is 40 % lower compared to natural ventilation.

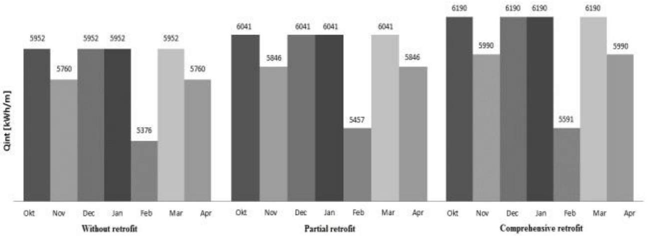

Fig. 6 Internal heat gains

In the calculation appears the specific area of the building A_f calculated from the external dimensions of the building, there is some difference in the results 2 %.

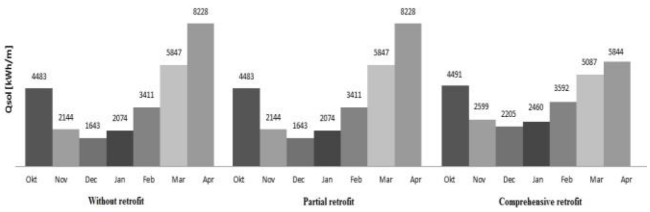

Fig. 7 Passive solar gains

In the variant of comprehensive retrofit it is used insulated triple glazed with solar energy transmittance of the window perpendicular to the glazing g⊥ respectively $g_{gl,n}$= 0,675; 0,75 previously versions, the difference is 11 %. The difference in the calculation of solar gains is 11 %.

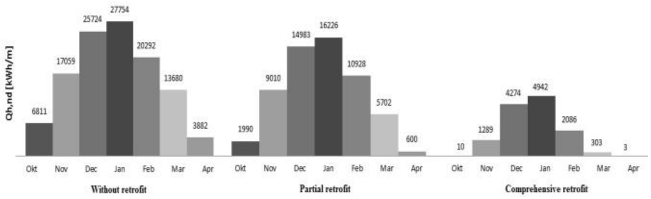

Fig. 8 Heat use for space heating

VI. Discussion

There are compared the resulting values of the heat use for space heating $Q_{h,nd}$, in the previous chapter, the two sections of the residential building.

Table 5 Comparison of different variants of the residential building

	Without retrofit	Partial retrofit	Comprehen. retrofit
Heat use for space heating [kWh/a]	115 202	59 439	12 908
Saving [kWh/a]	-	55 763	102 294
Saving [%]	-	48	89

Consider that the residential building is mostly made up of six sections. One complex consists of 20 residential buildings.

Table 6 Comparison of different variants of the complex

	Without retrofit	Partial retrofit	Comprehen. retrofit
Heat use for space heating [kWh/a]	6 912 120	3 566 340	774 480
Saving [kWh/a]	-	3 345 780	6 137 640
Saving [%]	-	48	89

As mentioned, from the year 2016 will be valid recommended values and from the year 2020 will be valid recommended target values. The State in Slovakia financially supports the insulation of residential buildings. This insulation can we characterize as a partial retrofit. It is necessary to think about the fact, that from 2016 and later from 2020, these residential buildings will no longer comply with the standard values. What happens then? They will insulation it again after a few years? Remain intact for many years before their status is again in an emergency? Will exhibit higher energy consumption. Instead, the state should support the comprehensive retrofit with the recommended target values. In this way the residential buildings meet the standard values, exhibited by lower energy consumption. Comprehensive retrofit settlement would be modernized, brought about by higher market prices, be more attractive and should offer a higher socio-cultural values.

VII. Conclusion

Residential houses of panel construction are refurbishing in Slovakia. Mostly it is a partial retrofit, which is not the best in the long term. From the comparison of the results of individual variants it is clear that such a recovery will bring savings of up to 50 % compared to the original state, i.m.

residential building without retrofit. But if it were comprehensive retrofit, achieve savings are of at least 85 %.

ACKNOWLEDGMENT

This post was created on the basis of the solution of experimental research of physical properties of fragments and construction details of the building envelope in thermal - humidity conditions VEGA 1/0835/14.

REFERENCES

[1] [cit. 2015-07-16]. Available on the Internet: http://www.beffa.eu/sk/smernice-20-20-20/

[2] [cit. 2015-01-04]. Available on the Internet: http://www.polir.cz/info/panelova-vystavba/panelove-domy/

[3] P. Ďurica, and M. Vertaľ, Vybrané state z konštrukcií budov. 1 diel. Bytová výstavba do roku 1970. Žilinská univerzita v Žiline. EDIS ŽUŽ. 2012. ISBN 978-80-554-0588-9.

[4] Z. Sternová a kol.: Obnova bytových domov. Hromadná bytová výstavba do roku 1970. JAGA group, Bratislava, 2001.

[5] Z. Sternová a kol.: Obnova bytových domov II. Hromadná bytová výstavba po roku 1970. JAGA group, Bratislava, 2002.

[6] [cit. 2015-01-04]. Available on the Internet: http://www7.statistics.sk

[7] STN 73 05 40: Tepelnotechnické vlastností stavebných konštrukcií a budov. Tepelná ochrana budov, časť 1: Terminológia, časť 2: Funkčné požiadavky, časť 3:Vlastnosti prostredie a stavebných výrobkov, časť 4: Výpočtové metódy, 2012.